COSTS OF HANDLING GROCERIES FROM WAREHOUSE TO RETAIL SALES FLOOR WITH WAREHOUSE PALLETS AND MOBILE CARTS

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PREFACE

This study was conducted under contract with the Edward M. Harwell Co., a Miami, Fla., management consulting firm. The contract was administered by John Bouma, investigations leader, Transportation and Facilities Research Division, Agricultural Research Service.

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Costs of Handling Groceries From Warehouse to Retail Sales Floor With Warehouse Pallets and Mobile Carts

By Paul F. Shaffer and Jack L. Runyan[1]

SUMMARY

The results of the cost comparison for the warehouse pallet and the mobile cart systems showed that the cart system costs $77.66 and the pallet systems costs $81.89 per 1,000 cases delivered 30 miles from the warehouse, a difference of $4.23. The results of this study indicate that availability of backhaul income (income resulting from the wholesalers' use of the trailer to transport products from suppliers to the warehouse on the return trip) is a key factor for warehouse and retail store managers to consider when deciding whether to adopt the pallet or mobile cart system, or a combination of both systems. Costs favor the pallet system when backhaul of more than $4.23 per 1,000 cases is available, because empty pallets do not occupy a large amount of trailer space.

Two problems arise when backhaul is considered in connection with the mobile cart system. First, if rigid carts are used for handling groceries no room is left in the trailer for backhaul merchandise after the empty carts are loaded at the retail store, a practice that results in increased costs for more carts or for sending a truck to return the carts to the warehouse. Second, if collapsible carts are used, handling costs will be higher because of the initial cost of the carts and the increased labor required to collapse and erect the carts.

Warehouse labor costs for order selection and trailer loading were $3.71 per 1,000 cases less with the mobile cart system than with the pallet system. The lower labor cost for order selection with the mobile cart system accounted for $3.43 of this difference.

Retail labor costs for unloading full pallets or carts from the delivery trailer and moving them to the sales floor, and for loading empty pallets or carts back on the trailer, were $3.84 per 1,000 cases less with the mobile cart system than with the pallet system. This difference is accounted for by the considerably lower labor costs for unloading the full carts from the trailer and moving them to the sales floor. Loading empty pallets back on the trailer actually required less time than loading empty carts back on the trailer (24 man-minutes per 1,000 cases for pallets as compared with 28 man-minutes per 1,000 cases for mobile carts). However, the lower time requirement for unloading full mobile carts from the trailer and moving them to the sales floor (64 man-minutes for the mobile carts as compared with 141 man-minutes for the pallets) more than offset the time saving in loading empty pallets back on the trailer.

Delivery costs were $7.47 per 1,000 cases less with the pallet system than with the mobile cart system. This difference in favor of the pallet system was due to backhaul income. Without backhaul income, the delivery costs with the pallet system would have been $3.53 per 1,000 cases more than delivery costs with the mobile cart system.

Managers should decide which system would be best for their operations by analyzing their existing situations to determine what additional facilities and equipment would be required at both the warehouse and the retail store to change to the new system, by calculating the costs of any additional facilities and equipment, and by estimating possible future trends in labor and equipment costs and in backhaul income fluctuations.

INTRODUCTION

The pressure generated by consumers for "holding the line on prices" is probably stronger in the food distribution industry than in any other industry. The problem of holding the line on prices is complicated by rising costs of labor, equipment, and other items that are necessary in operating a business. Basically, the challenge becomes one of how to hold the line on prices, in the face of increasing costs, and still maintain an acceptable profit margin. The only way the warehouse manager can meet this challenge is to

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increase productivity; that is, he must get more output from each unit of input, whether this unit is stated as dollars, man-hours, or equipment hours.

Many firms have increased their productivity by integrating various improved techniques into their particular grocery handling system. These techniques include the use of (1) motorized equipment, such as tuggers and long-nose pallet jacks, which eliminate the manual pushing of selector carts and allow the selection and movement of more than one pallet load per order-selecting trip, (2) a variety of unitized loading platforms, which eliminate the necessity of hand-stacking products in grocery trailers, (3) trailers with hydraulic tailgates or elevators, which allow faster unloading at the retail store, and (4) systems of full-case stocking, such as the Store Labor and Inventory Management (SLIM) system which provide for after-hours stocking and thus make possible the movement of larger loads into the sales area. To get the most output from each unit of input, the grocery warehouse manager must use all of the improved techniques possible in conjunction with his handling system.

Of the various modern systems used by grocery warehousemen for handling groceries from their storage location in the warehouse to the retail store shelves, the pallet system is the one most commonly used. The pallet most widely used in the system is the 48- by 40-inch Grocery Manufacturers of America (GMA) pallet. This system is a unified one; that is, the grocery cases remain on the pallet from the time they are placed there during order selection until they are removed for positioning at the retail store shelf for stocking.

The mobile cart used in these operations has wheels and is available in either a rigid or a collapsible design. It is also available in two sizes: 29 inches wide by 57 inches long by 72 inches high, or 27 inches wide by 57 inches long by 71 inches high. The cart can be obtained either with or without a shelf, which, when present, is 5 feet above the floor. The mobile cart system, like the pallet system, is unified.

Objective

The objective of this study was to determine and compare the costs of the two unified systems. The factors used were (1) the costs of labor and equipment for selecting cases and loading the trailer at the warehouse, delivering the cases from the warehouse to the retail store, and unloading the trailer at the store and moving the cases to the sales floor; and (2) the cost resulting from damage to the product in the delivery-unloading cycle in each of the two systems. The results of this study, the first concerned with the operating results from using mobile carts, will provide research data to help warehouse managers decide which of the two systems would be the most efficient for use in their individual warehouses.

Methodology

To accomplish the objective of the study, four grocery warehouses and eight of the retail stores receiving supplies from these warehouses were selected for analysis. Each of the four warehouses supplied two of the retail stores. Two of the four warehouses used the mobile cart system and two used the pallet system.

The warehouses were selected for study on the basis of the following criteria:

(1) A warehouse size ranging from 150,000 to 250,000 square feet.
(2) A warehouse layout organized by family commodity groups corresponding to the arrangement of the retail store shelf grouping.
(3) A general policy of shipping only full or approximately full trailer loads of grocery items to the retail stores receiving supplies from the warehouse.

The retail stores were selected for study on the basis of the following criteria:

(1) Receipt of grocery items from the warehouse only in full or approximately full trailer loads.
(2) Use of the SLIM system or a comparable system of full-case stocking.

For purposes of the study, data required were cost data and productivity data. Data on the costs for labor, equipment, and delivery were obtained from financial records of the four warehouses and eight retail stores studied and were averaged to eliminate differences resulting from geographic location. Production standards for warehouse and retail store operations, which include a 15-percent personal and fatigue allowance, were based on improved work methods developed through previous research in grocery handling. The jobs were divided into elements, and the time required to perform the elements was measured with a stopwatch. The time for the various elements was then adjusted to reflect the speed of the average operator working at a normal pace.

Results of the time studies provided the criteria for determining which of the four cooperating warehouses had the most efficient mobile cart system and which had the most efficient pallet system. The grocery-handling operations in these two warehouses were then used as a basis for the comparisons given in this report.

The labor at the warehouse was limited to "touch labor," which is labor directly involved with handling grocery cases in the order-selecting and loading operations. Touch labor, as used in this study, does not include forklift servicing of racks or checking and selecting orders in the Health and Beauty Aids department.

The warehouses studied were designed similarly, with the rail and truck docks at opposite ends of the building. The warehouse selection racks had 9-foot facings and were perpendicular to the docks. Both 48- by 40-inch and 40- by 32-inch pallets were used for storage.

Pallet System

The warehouse with the most efficient pallet system employed a long-nose pallet jack for both order selection and trailer loading. Each of these operations will be discussed separately in this section of the report.

Order Selection

Order selection consists of all work performed by the order selector from the time he obtains an invoice (list of items and cases ordered) until the order is complete and parked at the loading dock.

In the pallet system used for comparison, the selector obtained an invoice from the top of a stack of store invoices at the dispatcher's desk. He then proceeded to the loading dock where he positioned two 48- by 40-inch pallets on a long-nose pallet jack. With the pallets in position, he moved to his first order-selecting position, and began selecting orders from one side of one-way aisles. When both pallets were loaded (fig. 1), he moved the load to the loading dock. Pallets were not double stacked in the trailer, and, therefore, required a uniform pallet block ("pallet block" is the commonly used term for pallet load) to provide good stability in transit.

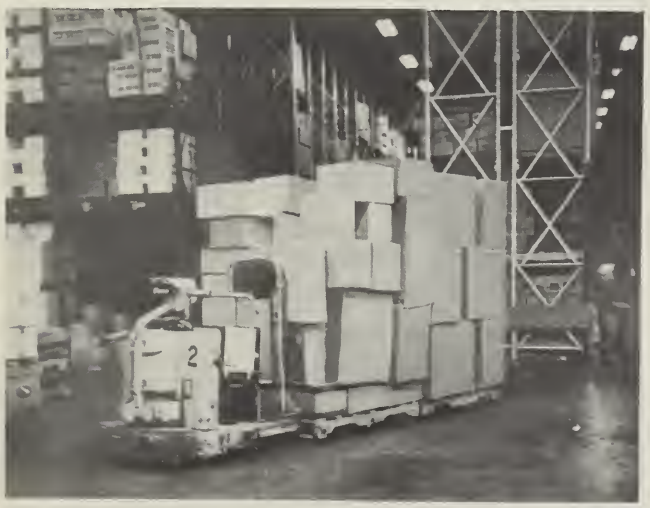

Figure 1. Extended long-nose pallet jack loaded with two pallets.

The standard time required for order selection was 297 man-minutes per 1,000 cases, for a productivity rate of 202 cases per man-hour (table 1). At an estimated average wage rate of $4.20 per hour,[2] the cost for selecting 1,000 cases was $20.79.

Table 1.—Labor time requirements, costs, and productivity[1] for assembling grocery orders with pallet system

Operational element	Time required per 1,000 cases	Cost per 1,000 cases[2]
	Man-minutes	*Dollars*
Preselection:		
Obtain long-nose pallet jack	2	.14
Obtain pallets	11	.77
Travel to first selection	9	.63
Selection:		
Obtain and position case	157	10.99
Reposition case	6	.42
Move between selections	36	2.52
Change aisles	7	.49
Postselection:		
Return to dock	12	.84
Secure load	2	.14
Miscellaneous selection elements	16	1.12
Total (elemental time and cost)	258	18.06
15-percent personal and fatigue allowance	39	2.73
Total (standard time and cost)	297	20.79

[1] Order-selection productivity rate was 202 cases per man-hour. (297 man-minutes ÷ 1,000 cases = 0.297 man-minute per case. 60 minutes per hour ÷ 0.297 man-minute per case = 202 per man-hour.)

[2] Based on estimated wage rate of $2.40 per hour, or $0.07 per minute.

Trailer Loading

The trailer loading operation, as used in this study, consisted of stripping the incoming trailer by removing all returnable containers, pallets and carts, and other materials returned from the stores, and of loading the outgoing trailer.

When the selector reached the dock, he frequently topped-off the loaded pallets with large, lightweight cases, such as cases of potato chips and bulky paper products, before guiding the load into the trailer. An employee called a dock helper assisted in the loading. When necessary, he handstacked cases so that larger loads could be accommodated.

[2] A warehouse wage rate of $4.20 per hour, averaged from data provided by the management of the warehouses studied, is used throughout this report. Firms that want to compare costs may substitute their own wage rate.

The standard time for trailer loading was 40 man-minutes per 1,000 cases, for a productivity rate of 1,500 cases per man-hour (table 2). At the estimated average wage rate of $4.20 per hour, the cost for loading 1,000 cases was $2.80.

Table 2.—Labor time requirement, costs, and productivity[1] per 1,000 cases for loading delivery trailers with the pallet system

Operational element	Time required per 1,000 cases	Cost per 1,000 cases[2]
	Man-minutes	*Dollars*
Stripping incoming trailer of empty pallets and other materials and placing items removed in storage ..	2	0.14
Loading outgoing trailers:		
Move load into trailer and return to dock	18	1.26
Top-off load	4	.28
Delay on dock	1	.07
Miscellaneous loading elements	10	.70
Total (elemental time and cost) ..	35	2.45
15-percent personal and fatigue allowance	5	.35
Total (standard time and cost)	40	2.80

[1] Loading productivity was 1,500 cases per man-hour. (40 man-minutes ÷ 1,000 = 0.040 man-minute per case. 60 minutes per hour ÷ 0.040 man-minute = 1,500 cases per man-hour.)

[2] Based on estimated wage rate of $4.20 per hour, or $0.07 per minute.

Mobile Cart System

Mobile carts pulled by radio-controlled tuggers were used in the selection of all grocery orders in the warehouse with the most efficient mobile cart system. The carts were rigid, as opposed to collapsible, and did not have shelves. The tabulating equipment used by this firm was programed to print one invoice page per cart load—about 45 cubic feet of space. The average cart load was 47.6 cases.

Order Selection

Before obtaining an invoice for selection, the order selector hooked one to three carts to a tugger. With this equipment, he travelled to the starting point of his assigned area and obtained an invoice for order selection. He then moved to his first order-selecting position and started selecting orders from one side of one-way aisles. When the carts were loaded or when the order selector had completed the invoice assigned to him, he moved the carts to the dock (fig. 2), where he unhooked and parked them.

The standard time for order selection was 248 man-minutes per 1,000 cases, for a productivity rate of 242 cases per man-hour (table 3). At the estimated average wage rate of $4.20 per hour, the cost for selecting 1,000 cases was $17.36.

Figure 2.—A tugger and train of three mobile carts.

Table 3.—Labor time requirement, costs, and productivity[1] per 1,000 cases for assembling grocery orders with mobile cart system

Operational element	Time required per 1,000 cases	Cost per 1,000 cases[2]
	Man-minutes	*Dollars*
Preselection:		
Obtain mobile carts	9	0.63
Travel to first selection	8	.56
Selection:		
Obtain and position case	125	8.75
Reposition case	6	.42
Move between selections	35	2.45
Change aisles	3	.21
Postselection:		
Return to dock	9	.63
Park carts	5	.35
Miscellaneous selection elements	16	1.12
Total (elemental time and cost) ..	216	15.12
15-percent personal and fatigue allowance	32	2.24
Total (standard time and cost)	248	17.36

[1] Order-selection productivity rate was 242 cases per man-hour. (248 man-minutes ÷ 1,000 cases = 0.248 man-minute per case. 60 minutes per hour ÷ 0.248 man-minute per case = 242 cases per man-hour.)

[2] Based on estimated wage rate of $4.20 per hour, or $0.07 per minute.

Trailer Loading

The loader did not start loading the delivery trailer until about half of the loaded carts were parked on the dock. The loading operation consisted of trailer stripping—removing empty carts from the incoming trailer—and loading the outgoing trailer with carts containing grocery items. To strip the trailer of the empty carts, the loader had to remove the load-locking bar used on the trailer to prevent the carts from moving during transit. The trailer-loading pattern used for full carts consisted of alternate groups of three carts, with each group positioned so that one cart was parallel with the side of the trailer and two carts were perpendicular to the side of the first cart. After the trailer was loaded, the loader installed the load-locking bar.

The standard time for the complete trailer-loading operation was 36 man-minutes per 1,000 cases for a productivity rate of 1,667 cases per man-hour (table 4). At the estimated average wage rate of $4.20 per hour, the cost for loading 1,000 cases was $2.52.

Table 4.—Labor time requirement, costs, and productivity[1] per cases for loading delivery trailers with mobile cart system

Operational element	Time required per 1,000 cases	Cost per 1,000 cases[2]
	Man-minutes	*Dollars*
Stripping incoming trailer of empty carts and other materials and placing items removed in storage . .	11	0.77
Loading outgoing trailer:		
Move load into trailer and return to dock	17	1.19
Reposition carts in trailer	1	.07
Install load-locking bar	1	.07
Reposition case	1	.07
Miscellaneous loading elements	1	.07
Total (elemental time and cost) . .	32	2.24
15-percent personal and fatigue . .	4	.28
Total (standard time and cost) .	36	2.52

[1] Loading productivity rate was 1,667 cases per man-hour. (36 man-minutes ÷ 1,000 cases = 0.036 man-minute per case. 60 minutes per hour ÷ 0.036 man-minute per case = 1,667 cases per man-hour.)

[2] Based on estimated wage rate of $4.20 per hour, or $0.07 per minute.

Total Warehouse Labor Time Requirement, Costs, and Productivity

Total warehouse labor time requirement, costs, and productivity for the pallet and the mobile cart systems are compared in table 5.

The greatest difference between the two systems is in order-selection productivity: 202 cases per man-hour with the pallet system and 242 cases per man-hour with the mobile cart system (tables 1 and 3, respectively). As shown in tables 1 and 3, respectively, the time for the operational element "obtain and position case" for the pallet system is 157 man-minutes, and for the mobile cart system 125 man-minutes, a difference of 32 man-minutes per 1,000 cases. The longer time required for the pallet system is caused by the extra time needed to arrange the pallet block pattern to insure stability in transit. Other differences between the two systems are small. The slighter differences are probably caused by differences in the experience of the order selectors observed during the study.

Table 5.—Summary of warehouse labor time requirements, costs, and productivity[1] per 1,000 cases for order selection and trailer loading with the pallet and the mobile cart systems[2]

Operational element	Pallet system		Mobile cart system	
	Time required per 1,000 cases	Cost per 1,000 cases	Time required per 1,000 cases	Cost per 1,000 cases
	Man-minutes	*Dollars*	*Man-minutes*	*Dollars*
Order selection	297	20.79	248	17.36
Trailer loading	40	2.80	36	2.52
Total (standard time and cost)	337	23.59	284	19.88

[1] Order-selection and trailer-loading productivity rate was 178 cases per man-hour with the pallet system (337 man-minutes ÷ 1,000 cases = 0.337 man-minute per case. 60 minutes per hour ÷ 0.337 man-minute per case = 178 cases per man-hour); and 211 cases per man-hour with the mobile cart system (284 man-minutes ÷ 1,000 cases = 0.284 man-minute per case. 60 minutes per hour ÷ 0.284 man-minute per case = 211 cases per man-hour).

[2] Based on data in tables 1 through 4.

The methods for handling grocery deliveries from the trailer to the sales floor differed among the order-receiving operations for the eight retail stores studied. The retail stores that received products on pallets used either docks at truck-bed level or "walkie forklift trucks." The retail stores that received products on mobile carts used either docks at truck-bed level or trailers equipped with hydraulic tailgates or elevators. In most of the stores studied, the loaded pallets or carts were moved directly from the trailer to the cross aisle of the stores, from which position the cases were spotted (positioned on the floor in front of proper shelf location). In the other stores, the loaded pallets or carts were parked in the backroom of the stores after being unloaded from the trailer. Then, after the stores had closed for the day, or early the next morning, the cases were spotted directly from the backrooms, or the loaded pallets or carts were moved from the backrooms to the cross aisles of the stores for the case-spotting operation.

The retail store order-receiving operation with the most efficient system used docks at truck-bed level and spotted cases from pallets or carts parked in the cross aisle. Other methods for handling groceries were not examined because of their inherent inefficiencies. The elements analyzed in the receiving operation were limited to the unloading and parking of full pallets or carts, the movement of the loaded pallets or carts to the retail sales floor, and the assembling and loading of empty pallets or carts. The case-spotting and shelf-stocking operations were not affected by whether pallets or carts were used, because the loaded units were left in the cross aisles in both systems. Therefore, case spotting and shelf stacking were not included in the retail order-receiving elements analyzed.

Pallet System

Of the stores using the pallet system, the one with the most efficient system received loaded pallets stacked one high in the incoming trailer. The driver and a crew of two men unloaded the pallets from the trailer and moved them to the cross aisle of the store. After the merchandise was removed from the pallets, the empty pallets were loaded on the outgoing trailer for return to the warehouse. Although the driver assisted in the unloading, his salary was charged to warehouse delivery costs rather than to retail store costs.

The standard time required for unloading the pallets from the incoming trailer and moving them to the sales floor and for loading empty pallets back on the outgoing trailer was 165 man-minutes (110 man-minutes for retail store employees plus 55 man-minutes for the driver) per 1,000 cases (table 6), for a productivity rate of 364 cases per man-hour. At an estimated wage rate of $3.60 per hour,[3] the retail store labor cost for the retail order-receiving operation with the warehouse pallet system was $6.60 per 1,000 cases.

Table 6.–Labor time requirement, costs, and productivity[1] per 1,000 cases for receiving grocery orders delivered on pallets at the retail store

Operational element	Time required per 1,000 cases	Cost per 1,000 cases[2]
	Man-minutes	*Dollars*
Unloading full pallets from incoming trailer and moving them to sales floor	123	8.20
Loading empty pallets into outgoing trailer (includes assembling empty pallets in sales area and moving them to truck dock)	21	1.40
Total (elemental time and cost)	144	9.60
15-percent personal and fatigue allowance	21	1.40
Total (standard time and cost)	165	11.00
Charged to the retail store receiving function	110	6.60
Charged to the delivery expense	55	4.40

[1] Order-receiving productivity rate was 364 cases per man-hour. (165 man-minutes ÷ 1,000 cases = 0.165 man-minute per case. 60 minutes per hour ÷ 0.165 man-minute per case = 364 cases per man-hour.)

[2] Based on estimated wage rate of $3.60 per hour, or $0.06 per minute for store employees and $4.80 per hour, or $0.08 per minute for the driver.

Mobile Cart System

In the store with the most efficient mobile cart system, the grocery order was delivered late in the afternoon, unloaded by personnel, and parked in the backroom. The backroom was large enough to accommodate a trailer load of carts easily and still allow performance of necessary duties. After the store closed, the loaded carts were moved to the cross aisles for case spotting.

The standard time for unloading the carts from the incoming trailer and moving them to the sales floor and for loading empty carts on the outgoing trailer was 92 man-minutes per 1,000 cases–46 man-minutes for store employees plus 46 man-minutes for the driver (table 7)– for a productivity rate of 652 cases per man-hour. At the estimated wage rate of $3.60 per hour, the retail labor cost for the order-receiving operation with the mobile cart system was $2.76 per 1,000 cases.

[3] A retail wage rate of $3.60 per hour, averaged from data provided by the cooperating retail stores, is used throughout this report. Firms that want to compare costs may substitute their own wage rate.

Table 7.—Labor time requirement, costs, and productivity[1] for receiving grocery orders delivered in mobile carts

Operational element	Time required per 1,000 cases	Cost per 1,000 cases[2]
	Man-minutes	*Dollars*
Unloading full mobile carts from incoming trailer and moving them to sales floor	56	3.92
Loading empty mobile carts into out-going trailer (includes assembling empty mobile carts in sales area and moving them to truck dock)	24	1.68
Total (elemental time and cost)	80	5.60
15-percent personal and fatigue allowance	12	.84
Total (standard time and cost)	92	6.44
Charged to the retail store receiving function	46	2.76
Charged to the delivery expense	46	3.68

[1] Order-receiving productivity was 652 cases per man-hour. (92 man-minutes ÷ 1,000 cases = 0.092 man-minute per case. 60 minutes per hour ÷ 0.092 man-minute per case = 652 cases per man-hour.

[2] Based on estimated wage rate of $3.60 per hour or $0.06 per minutes for retail store employees and $4.80 per hour or $0.08 per minute for the driver.

Total Retail Store Labor Time Requirement, Costs, and Productivity

Total retail store labor time requirement, costs, and productivity are compared in table 8.

The greatest difference between the two systems is in the time required to unload the products and move them from the incoming trailer to the sales floor. The pallet system requires more time because the pallet jack must be engaged with the loaded pallet in the trailer and disengaged after the pallets are parked on the sales floor, and the loaded pallets are more difficult to maneuver and must be manually supported while they are being moved between trailer and sales floor.

Table 8.—Summary of retail store labor time requirement, cost, and productivity[1] per 1,000 cases for receiving grocery orders delivered on pallets and in mobile carts[2]

Operational element	Pallet system		Mobile cart system	
	Time required per 1,000 cases	Cost per 1,000 cases	Time required per 1,000 cases	Cost per 1,000 cases
	Man-minutes	*Dollars*	*Man-minutes*	*Dollars*
Unloading loaded pallets and cart from incoming trailer and moving them to sales floor	[3] 94	5.64	[4] 32	1.92
Loading empty pallets and carts into outgoing trailer	[5] 16	.96	[6] 14	.84
Total (standard time and cost)	110	6.60	46	2.76

[1] Order-receiving productivity rate was 364 cases per man-hour with the pallet system (see footnote 1, table 6, for calculations) and 652 cases per man-hour with the mobile cart system (see footnote 1, table 7, for calculations).

[2] Based on Data in tables 6 and 7.

[3] 82 man-minutes + 12-minutes personal and fatigue allowance.

[4] 28 man-minutes + 4-minutes personal and fatigue allowance.

[5] 14 man-minutes + 2-minutes personal and fatigue allowance.

[6] 12 man-minutes + 2-minutes personal and fatigue allowance.

DELIVERY COSTS

Many factors affect delivery costs. The factors that are influenced particularly by the method of handling groceries are: (1) costs for drivers' time, (2) fixed costs for delivery equipment during trailer loading, unloading and traveling (depreciation, interest, insurance, and taxes), (3) intransit and unloading damage, and (4) potential for backhaul income.

The costs for drivers' time were determined by averaging the salaries paid to drivers in the warehouses studied. A salary cost of $4.80 an hour for drivers was charged to both grocery-handling systems.

The fixed costs for delivery equipment during trailer loading, unloading and traveling were determined by estimating the depreciation and interest costs per hour of use (table 9). Warehouse managers who use this study as a basis for deciding which system they should use should include insurance and tax costs when determining their fixed costs for delivery

Table 9.—Determining fixed costs per hour for delivery equipment

Equipment	Purchase cost[1]	Salvage value	Average life[1]	Annual depreciation cost[2]	Annual interest cost[3]	Total annual cost	Annual time in use[1]	Fixed costs per hour
	Dollar	*Dollar*	*Years*	*Dollar*	*Dollar*	*Dollar*	*Hours*	*Dollar*
Tractor	22,600	[5] 3,390	6	3,202	910	4,112	3,120	1.32
Trailer	13,300	[6] 400	8	1,613	480	2,093	2,600	.81
Total	35,900	3,790	---	4,815	1,390	6,205	5,720	2.13

[1] Averaged from data provided by managment of the four warehouses studied. Does not include insurance and tax costs.

[2] Calculated by using the straight line depreciation method (purchase cost - salvage value ÷ average life).

[3] Calculated as follows: purchase cost + salvage value ÷ 2 = average investment. Average investment x 7 percent (the prevailing interest rate at the time of study) = annual interest cost.

[4] Calculated as follows: total annual costs ÷ annual time in use.

[5] Assumed to be 15 percent of the purchase cost, based upon a survey conducted by the National American Wholesale Grocers Association. The assumption was confirmed by local dealers.

[6] Obtained from local dealers.

equipment during trailer loading, unloading and traveling. These costs were not included as part of the fixed costs used in the comparison because the cooperating warehouse managers reported their tax and insurance costs as part of total fleet-operating costs. Because the same type of delivery equipment can be used for both pallets and carts if retail stores have docks at truck-bed level, the same total hourly fixed costs for delivery equipment during trailer loading and unloading were charged to both handling systems.

Data on intransit damage, including damage incurred both during transit and unloading at the retail store, and data on backhaul income (income resulting from the wholesalers' use of the trailer to transport products from suppliers to the warehouse on the return trip), were obtained from records supplied by cooperators. Both intransit damage and backhaul income were based on the number of cases shipped to retail stores. Backhaul income was allocated to the pallet system. However, no backhaul income was allocated to the mobile cart system because the warehouse studied used rigid carts that did not leave space for backhaul use. When rigid carts are used, backhauling can be practiced only if the carts are left at the retail stores. This practice results in increased costs for additional carts or for sending a truck to return the carts to the warehouse. Had collapsible carts been used, approximately 75 percent of the trailer capacity would have been available for backhaul. However, the additional cost for collapsible carts and the labor costs for collapsing and setting up the carts would have to be balanced against the potential backhaul income. When carts equipped with shelves are used, the added cost of lost trailer space would also have to be balanced against the potential backhaul income.

To facilitate the comparison between delivery costs per 1,000 cases for the two systems, the researchers calculated costs for an assumed 60-mile round trip, traveled at 30 miles per hour. It was assumed that the retail stores receiving deliveries had docks at truck-bed level and that the same type of delivery equipment could be used for both systems. Fleet costs, such as gas, oil, tires, maintenance, and licenses, were averaged from data provided by the four warehouses studied and were assumed to be identical for both systems for the 60-mile round trip. The cost comparisons calculated for the assumed trip are shown in table 10.

Table 10.—Delivery costs per 1,000 cases delivered 30 miles from the warehouse with the pallet and the cart systems

Item	Costs per 1,000 cases	
	Pallet system	Mobile cart system
	Dollars	*Dollars*
Drivers' time	14.00	13.28
Fixed costs for delivery equipment[1]	7.63	7.17
Intransit damage	4.95	2.60
Other fleet-operating costs	21.92	21.92
Gross cost	48.50	44.97
Backhaul income	11.00	---
Net cost	37.50	44.97

[1] Fixed cost, based on data in table 9.

Pallet System

The cost for drivers' time for the pallet system during the assumed trip was $14.00 per 1,000 cases (2 hours for driving + 55 minutes for unloading trailer and loading empty pallets back onto the trailer at the retail store x $4.80 per hour).

The fixed costs for the delivery equipment during loading, traveling and unloading were $7.63 per 1,000 cases (2 hours for traveling + 40 minutes for loading at the warehouse + 55 minutes for unloading the trailer and loading empty pallets back on the trailer at the retail store x $2.13 per hour).

The data for intransit damage cost, other fleet-operating costs, and backhaul income were estimated from records provided by the officials of the cooperating warehouses that used the pallet system. The net cost for delivering 1,000 cases of groceries for the 60-mile round trip with the pallet system was estimated at $37.50.

Mobile Cart System

The cost for drivers' time for the mobile cart system during the hypothetical trip was $13.28 (2 hours for driving + 46 minutes for unloading trailer and loading empty carts back on the trailer at the retail stores x $4.80 per hour) per 1,000 cases.

The fixed costs for delivery equipment during trailer loading, traveling and unloading were $7.17 per 1,000 cases (2 hours for traveling + 36 minutes for loading at the warehouse + 46 minutes for unloading the trailer and loading empty carts back on the trailer at the retail store x $2.13 per hour).

The data for intransit damage cost and other fleet-operating costs were estimated from records provided by the officials of the cooperating warehouses that used the mobile cart system. No backhaul income was calculated for the mobile cart system because only rigid carts, which could not be collapsed to provide space, were used by the cooperating warehouses.

The total cost for delivering 1,000 cases of groceries for the 60-mile round trip with the mobile cart system was estimated at $44.97.

Total Delivery Costs

The individual delivery costs for the mobile cart system were lower than similar costs with the pallet system (table 10). However, the net delivery costs with the pallet system were $7.47 per 1,000 cases lower than similar costs with the mobile cart system because pallet system costs were partly offset by backhaul income. Had no backhaul income been earned, the pallet system's net delivery cost would have been higher by $3.53 per 1,000 cases shipped than the net delivery cost with the mobile cart system.

COSTS FOR EQUIPMENT, DOCK OWNERSHIP, AND STRUCTURAL ALTERATIONS

The cost of the particular grocery-handling system used is directly related to equipment costs, receiving-dock ownership expenses, and any alterations to facilities required to accommodate either pallets or mobile carts. For the warehouses that cooperated in this study, the only cost associated with these factors was the cost for equipment used in order selection and order loading. Receiving-dock ownership expenses are wholly a retail store cost factor, and none of the cooperating warehouses were required to alter the warehouse structures to accommodate pallets or carts. However, costs for the handling systems used by the cooperating retail stores included not only costs for the manual pallet jacks used in receiving orders, but also dock ownership expenses and costs for altering the receiving-dock doors to accommodate loaded pallets or mobile carts efficiently and to facilitate moving loaded pallets or carts to the retail sales floor. Table 11 indicates that costs for retail store dock ownership (which include the cost of the manual pallet jacks) and retail store structural alterations are smaller than the costs for warehouse equipment—particularly for the long-nose pallet jacks, radio-controlled tuggers, and mobile carts.

Warehouse equipment used with the pallet system includes the long-nose pallet jacks and warehouse pallets. The total cost for this equipment, and for retail

Table 11.—Warehouse equipment, retail store equipment, dock ownership, and door alterations costs per 1,000 cases with the pallet and mobile cart systems

Equipment	Cost per 1,000 cases	
	Pallet system	Cart system
	Dollars	*Dollars*
Warehouse equipment:		
Long-nose pallet jacks	[1] 1.80	---
Radio-controlled tuggers	---	[2] 2.20
Warehouse pallets	[3] 1.00	---
Mobile carts	---	[4] 7.70
Retail store dock ownership and structural alterations	[5] .40	.15
Total	3.20	10.05

[1] Based on annual costs (depreciation, maintenance, and interest) amounting to $716 ÷ 395,200 cases per pallet jack per year.

[2] Based on annual costs (depreciation, maintenance, and interest) amounting to $1,036 ÷ 476,320 cases per tugger per year.

[3] Based on annual cost (27 pallets per retail store x $4.80 per pallet 1 year estimated life) amounting to $129.60 ÷ 130,000 cases shipped per year to each retail store supplied.

[4] Based on annual costs (depreciation, maintenance, and interest for 35 carts per retail store) amounting to $997 ÷ 130,000 cases shipped per year to each retail store supplied.

[5] Includes cost for manual pallet jacks.

store dock ownership expenses (including costs for the manual pallet jack) and structural alterations was $3.20 per 1,000 cases. Warehouse equipment used with the mobile cart system included the radio-controlled tuggers used to pull the carts during order selection, and the mobile carts. The total cost for this equipment, and for retail store dock ownership expenses and door alterations, was $10.05 per 1,000 cases.

Table 11 shows that the costs for the radio-controlled tuggers and the mobile carts are higher than the costs for the long-nose jacks and warehouse pallets. The largest cost difference is between the respective costs of the warehouse pallets and the mobile carts. However, the cost differential between the equipment used for the pallet and for the mobile cart systems should not be the only factor considered by the warehouse or retail store manager in deciding on the best grocery-handling system to use. Such a decision should be based on a careful consideration of all the cost factors discussed in this report.

TOTAL HANDLING COSTS

The total costs of handling groceries from their storage location in the warehouse to the retail store selling area with the pallet and mobile cart systems are shown in table 12.

The results of the cost comparison show the mobile cart system costing $77.66 and the pallet system costing $81.89 (gross cost) per 1,000 cases delivered from the warehouse, a difference of $4.23. According to the results of the study, availability of backhaul is a key factor for warehouse and retail store managers to consider when deciding whether to adopt the pallet or mobile cart system or whether to adopt a combination of both systems. Costs favor the pallet system when backhaul income of more than $4.23 per 1,000 cases is available, because empty pallets do not occupy a large amount of trailer space.

Table 12.–Total warehouse and retail store costs per 1,000 cases for handling groceries from the warehouse to the retail store sales floor with the pallet and the mobile cart systems

Item	Cost per 1,000	
	Pallet system	Mobile cart system
	Dollars	*Dollars*
Warehouse labor:		
Order assembly	20.79	17.36
Trailer loading	2.80	2.52
Retail store labor for order receiving	6.60	2.76
Delivery	48.50	44.97
Equipment, retail store dock ownership expenses, and instructural alterations	3.20	10.05
Gross cost	81.89	77.66
Backhaul income	−11.00	---
Net cost	70.89	77.66

RECOMMENDATIONS

According to the results of this study, one system cannot be recommended over the other. The best system is the system most adaptable to existing operating techniques and conditions.

Management should use five basic steps to determine which system to adopt. The first step is to study existing facilities and equipment to determine what is available. The second step is to determine what additional equipment and facilities would be needed to adopt the particular system. The third step is to determine the cost of additional equipment and facilities. The fourth step is to estimate, through management experience and personal judgment, the likely future labor and equipment costs and backhaul income. The final step is to balance the costs for additional equipment and facilities against the

potential savings of the proposed system. If the costs are greater than the potential savings, the proposed system should not be adopted.

The costs of changing from one system to another are relatively simple to determine. These costs can be obtained from equipment dealers and building contractors. However, estimating future labor and equipment costs is not so simple. Since 1960, labor costs in the food distribution industry have increased approximately 70 percent. Equipment costs have generally followed the same path as labor costs. No attempt will be made in this report to estimate future labor and equipment costs. However, the following examples are given to show the effect of increased labor and equipment costs and of flucuations in backhaul income on the relative costs of the two systems.

Example No. 1:

Assuming that labor costs used in this study increase by 10 percent while equipment costs remain constant and backhaul income is excluded, the following would result:

(1) The cost per 1,000 cases delivered 30 miles from the warehouse with the pallet system would increase to $86.31, or by 5.40 percent.
(2) The cost per 1,000 cases delivered 30 miles from the warehouse with the mobile cart system would increase to $81.26, or by 4.64 percent.
(3) The savings potential for the mobile cart system would increase to $5.05 per 1,000 cases.

Example No. 2:

Assuming that equipment costs used in this study increase by 10 percent while labor costs remain constant and backhaul income is excluded, the following would result:

(1) The cost per 1,000 cases delivered 30 miles from the warehouse with the pallet system would increase to $82.98, or by 1.30 percent.
(2) The total cost per 1,000 cases delivered 30 miles from the warehouse with the mobile cart system would increase to $79.40, or by 2.24 percent.
(3) The savings potential for the mobile cart system would decrease to $3.58 per 1,000 cases.

Backhaul income was excluded from the two previous examples. However, when backhaul is available, the resulting income will be used to offset delivery costs. To equate the costs for the two handling systems analyzed, backhaul income for the pallet system would have had to amount to $4.23 per 1,000 cases shipped. Backhaul income in excess of $4.23 per 1,000 cases shipped would favor the pallet system. Backhaul income of less than $4.23 per 1,000 cases shipped would favor the mobile cart system.

In all probability, labor and equipment costs will increase. The possible magnitude of these increases is unknown. As shown in the two examples, the cost for the mobile cart system was lower than the cost for the pallet system when 10-percent increases in labor and in equipment costs were assumed. However, backhaul income can offset the cost difference between the two systems. Managers should give careful consideration to present and potential backhaul income when deciding which system to adopt. The manager should also consider the merits of using the mobile cart system when no backhaul is available and the pallet system when backhaul is available. By using such a combination of systems, the manager would be exploiting the merits of both systems.

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